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Aluminum and gallium nuclei as microscopic probes for pulsed electron-nuclear double resonance diagnostics of electric-field gradient and spin density in garnet ceramics doped with paramagnetic ions

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Abstract

© 2018 Author(s). The presence of aluminum and gallium isotopes with large nuclear magnetic and quadrupole moments in the nearest environment of impurity ions Mn2+and Ce3+in garnets made it possible to use hyperfine and quadrupole interactions with these ions to determine the spatial distribution of the unpaired electron and the gradient of the electric field at the sites of aluminum and gallium in the garnet lattice. High-frequency (94 GHz) electron spin echo detected electron paramagnetic resonance and electron-nuclear double resonance measurements have been performed. Large difference in the electric field gradient and quadrupole splitting at octahedral and tetrahedral sites allowed identifying the positions of aluminum and gallium ions in the garnet lattice and proving that gallium first fills tetrahedral positions in mixed aluminum-gallium garnets. This should be taken into account in the development of garnet-based scintillators and lasers. It is shown that the electric field gradient at aluminum nuclei near Mn2+possessing an excess negative charge in the garnet lattice is ca. 2.5 times larger than on aluminum nuclei near Ce3+.

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